FPSOs Present and Future Workshop

Presentations

Session IV

Conversions vs. New Builds

June 8, 2000

Table of Contents

Fred Shumaker
Oceaneering

SESSION IV
CONVERSION VS. NEW-BUILDS
TECHNICAL ISSUES

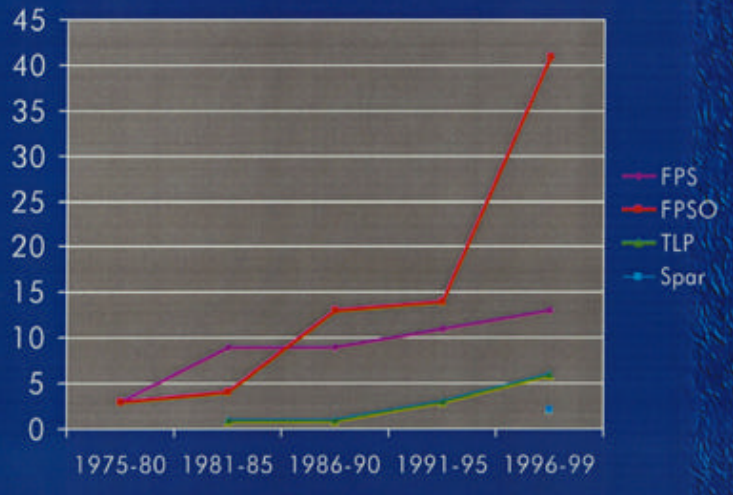
MODERATOR

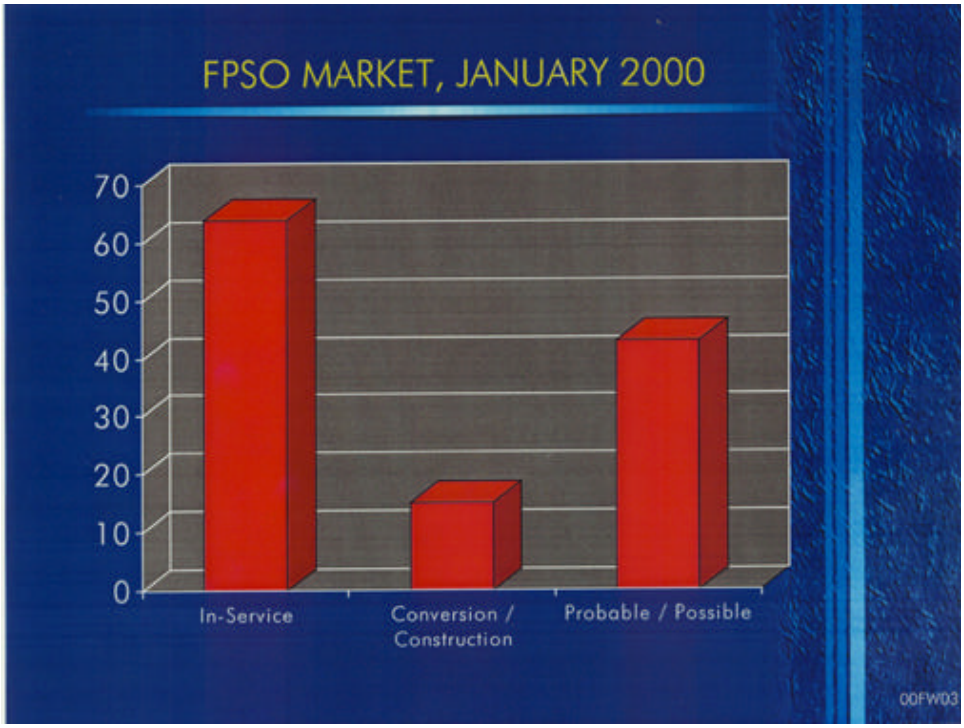
Fred E. Shumaker	**Oceaneering International, Inc.**

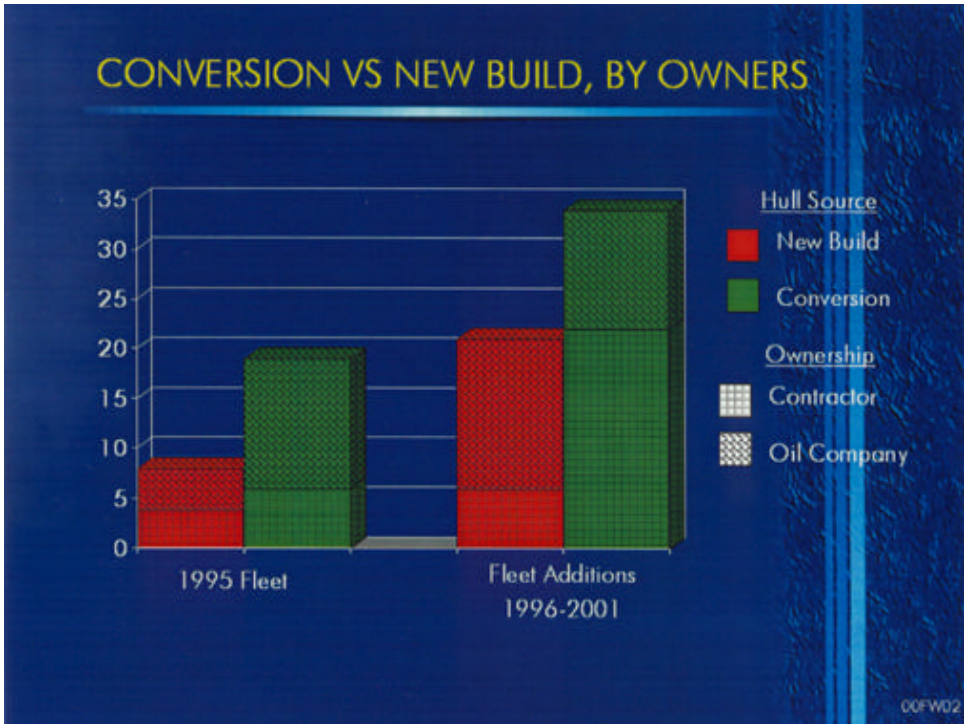
PANELIST

Roger D. Leick	ExxonMobil Upstream Development Co.
James M. Magill	United States Coast Guard
Peter Noble	ABS Group
Lawine Sturdevant	Modec international LLC

FLOATING PRODUCTION UNITS ENTERING SERVICE BY FIVE-YEAR PERIODS




FPSO MARKET, JANUARY 2000
70
60
50
40
30
20
10
0
In-Service
Conversion / Construction
Probable / Possible
00FW03


CONVERSION VS NEW BUILD, BY OWNERS
35
30
25
20
15
10
5
0
1995 Fleet
Fleet Additions 1996-2001
Hull Source
New Build
Conversion
Ownership
Contractor
Oil Company
00FW02

Roger Leick
ExxonMobil

FPSOs - Present and Future
Session IV - Conversions vs. New Builds

Key Drivers

- High confidence in the integrity of the asset over the expected life of the field
- Minimum life cycle cost of the asset
- Severity of environmental conditions
- Regulatory requirements
- Project schedule

FPSOs - Present and Future
Session IV - Conversions vs. New Builds

Conversion Considerations

- Potential candidate for:
  - Short to medium anticipated field life (5-15 years)
  - Fast deployment (schedule advantage)
  - Favorable regulatory environment
- Tanker selection criteria critical
  - Hull generally designed for 20 years in world wide trade
  - Original construction quality important
  - Service history & repair records can indicate future expectations
  - Accessibility for THOROUGH inspection reduces surprises later
  - Remaining life of vessel could limit flexibility to extend life of field
- Availability/cost of conversion candidates
  - Market for ‘70s vintage tankers could become tight in next 5+ years
  - Few ‘80s vintage tankers built; most reflect aggressive cost cutting
  - Newer tankers could reduce cost advantage

FPSOs - Present and Future
Session IV - Conversions vs. New Builds

New Build Considerations

- Probable candidate for high volume development with anticipated long field life (20+ years)
  - More flexibility to accommodate field life extension w/o dry doc king
- High confidence in baseline condition of asset
  - Should minimize future inspection/maintenance requirements
  - Can design-in FPSO-specific features; particularly advantageous for severe environments
- Ability to accommodate more stringent environmental and regulatory requirements
- Better opportunity to have an integrated asset to operate
  - Reduce marine vs topside mentality in operation
- Need to balance Offshore vs Shipyard standards for hull and marine systems
  - Creep towards Offshore standards increases cost

James Magill
U.S. Coast Guard

FPSO WORKSHOP

SESSION IV:
CONVERSIONS VS. NEW BUILDS

James M. Magill

UNITED STATES COAST GUARD
Washington D.C.

Assumptions for this Presentation

1. United States Regulatory Scheme as it applies to FPSOs
2. Focus of discussion is U.S. Coast Guard Requirements
3. The position presented represents the current policies of the United States Coast Guard

A Dual Regulatory Approach

- FPSO Jurisdiction on the U.S. Outer Continental Shelf (OCS)
  - Minerals Management Service (MMS)
  - U.S. Coast Guard
- USCG/ MMS MOU
  - New MOU signed December 16, 1998
  - Clarifies agency responsibilities and developed with considerable industry input

***USCG FPSO** PRESENT*
REGULATIONS
Conversions & New Builds

- 33 CFR Sub N - OCS Regs
- 143.120 Floating OCS Facilities
- Policy Letter NO. 13-92
- OPA '90 Regulation - Double Hull Regs

USCG FPSO PROPOSED REVISIONS TO REGULATIONS Conversions & New Builds

Subchapter "N" Revisions for FPSOs will:-

- Incorporate Policy Letter
- Include other revisions common to all offshore units
- Reference requirements for OPA '90 Regulation - Double Hull Regs

USCG FPSO PRESENT REQUIREMENTS Conversions & New Builds

- *U.S. flag FPSOs*
  - Must undergo USCG "Plan Review & Approval" and inspection during construction
  - Must be issued a Coast Guard Certificate of Inspection
  - Must undergo annual C.G. inspection for life of FPSO

USCG FPSO REQUIREMENTS
Conversions & New Builds

Foreign flag FPSOs

- Must receive a USCG Letter of Compliance (LOC) after initial inspection, and annual inspection thereafter
- Expected to comply with International treaties
  - SOLAS (Safety of Life at Sea)
  - MARPOL 73/78 (Pollution prevention)
- Non-signatory countries or failure to comply with international treaties will result in:
  - Treatment as a U.S. flag vessel

FPSO POLICY CLARIFICATION
Conversions & New Builds

- ***Are FPSOs considered vessels for regulatory purposes?***
  - **Answer: Yes (Title 1 United States Code, Section 3)**
- ***Is produced oil on board an FPSO considered cargo?***
  - **Answer: Yes.**
  - **Tank vessel requirements apply, including requirements for a Tankerman- PIC**
  - **OPA'90 double hull requirements apply** if oil is stored in hull tanks adjacent to the sea

CONVERSION FPSOs

(U.S. Flag & Foreign)

Do Conversions have to meet OPA-90 double hull standards?

- Answer: Yes, if considered a MAJOR CONVERSION, and oil is stored in hull tanks adjacent to the sea.
- Existing single hull FPSOs built before June 30, 1990 may operate on the U.S. OCS…but are subject to the OPA-90 "phase out" schedule.
- In general…FPSOs undergoing major conversion after June 30, 1990 must comply with the double hull requirements in 33 CFR 157.10d
- Each vessel undergoing a conversion will be considered on a case-by-case basis as to whether it is a major conversion for the application of OPA-90 double hull requirements

CONVERSION FPSOs

(U.S. Flag & Foreign)

What constitutes a MAJOR CONVERSION?

Per 46 USC 2101 (14a) :-

Major conversion means a conversion of a vessel that-

- (A) Substantially changes the dimensions or carrying capacity of the vessel;
- (B) Changes the type of the vessel;
- (C) Substantially prolongs the life of the vessel; or
- (D) Otherwise so changes the vessel that it is essentially a new vessel, as decided by the Secretary

CONVERSION FPSOs

(U.S. Flag & Foreign)

- No converted FPSOs in U.S. OCS at this time
- In addition to meeting Coast Guard regulations in 33 CFR Subchapter N for U.S. and foreign flagged FPSOs the Coast Guard will likely require some type of enhanced survey, which would include :-
  - Proof that a fatigue assessment has been performed to assure remaining fatigue life of major structural members is sufficient for life as FPSO, particularly for older units
  - Proof of special hull inspection to assess present steel thickness

USCG NATIONAL OFFSHORE SAFETY ADVISORY COMMITTEE (NOSAC)

- NOSAC Subcommittee formed recently to identify any added risks in deepwater that have not been assessed.
- Task statement includes :-
  - Risks associated with conversion of tankers to FPSOs
  - Risks from collision with other vessels.
- Report will be used to assess present regulations

SUMMARY

- MMS & USCG have Joint jurisdiction of FPSOs
- CG/MMS MOU clarifies agency responsibilities
- FPSOs considered tanks vessels by USCG
- Coast Guard COI or LOC is required
- OPA-90 hull requirements....case by case basis and only if oil stored in hull tanks adjacent to sea
- NPRM on 33 CFR Subchapter N is a Roadmap for determining CG position & philosophy on FPSOs
- NOSAC Subcommittee identifying any deepwater risks including conversion of tankers to FPSOs

Lawnie Sturdevant
MODEC International LLC

FPSOs Present and Future

Conversions vs. New Builds:

Perspectives from an FPSO Builder and Operator

Presented by:
Lawnie Sturdevant
Manager, Sales & Marketing
MODEC International LLC

Workshop Conducted by Offshore Technology Research Center
June 7 & 8, 2000

FPSOs Present and Future

Agenda

- Decision Factors: Conversion vs. New Build Decision
- MODEC Experience Summary
- Critical Engineering Concerns
- How to Avoid Them
- Conclusion

FPSOs Present and Future

Main Factors in Decision Making
Conversion vs. New Build

- **Service Life without Drydocking**
- **Cost**
- **Project Schedule**
- **Operator Preference**
- **Regulatory Requirements**

MODEC EXPERIENCE

- History
  - General Contractor Specialized in Marine Equipment
  - Pioneer and Leader in FPSO, FSO & TLP Technology
  - Founded in 1968
  - Focus on Offshore Industry
- Present Corporate Organization:

MODEC INTERNATIONAL LLC

(A Company of MITSUI & FMC Group)

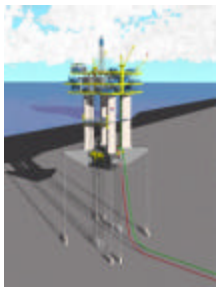
MODEC EXPERIENCE

1st Wave:
Construction
Vessels

DB 102 ➡

2nd Wave:
Drilling Rigs

3rd Wave:
FPSO & FSO



4th Wave:
MOSES TLP

FPSO/FSO/TLP EXPERIENCE

Twelve (12) Major Projects Executed as the General Contractor:

- MARATHON Kakap Natuna FPSO
- CHEVRON Anoa Natuna FPSO
- JHN Lufeng 13-1 FSO
- AMOCO Liuhua 11-1 FPSO
- SHELL TODD Maui B FPSO
- CHEVRON Escravos LPG FSO
- MARATHON Tchatamba MOPU + FSO (Gabon)
- PEMEX Cantarell Field FSO (352,000 DWT; 800,000 BOPD)
- BHPP Elang FPSO (Australia)
- EXXON FPSO New Hull Concept Design (900m W.D., Angola)
- PETROBRAS P-37 FPSO (900 m Water Depth)
- BHPP Buffalo Field FPSO (Australia)

Current Projects in Progress:

- MOSES TLP for El Paso Energy's Prince Field (GOM)
- VietNam White Tiger FSO (new build)

MODEC EXPERIENCE

Conversion

- 9 projects completed

Longest FPSO in service:
14 years, with no downtime.
Marathon Kakap Natuna FPSO.

Largest FPSO in design throughput: 300,000 BFPD.
Amoco Liuhua FPSO

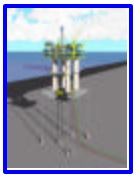
Largest FSO in design throughput: 800,000 BOPD.
Pemex Cantarell FSO

New Build

- 2 FSO projects completed
- 1 FSO in construction
- 1 TLP in construction

Chevron Anoa
Natuna FSO

Chevron
Escravos
(Nigeria): World's
First New Build
LPG FSO



El Paso Energy
Prince Field (GOM)

Amoco Liuhua 11-1 FPSO

Harsh Environment, High Capacity FPSO

- Award 8/93
- Install 3/96
- Typhoon prone area (hit by Super Typhoon Sally in 9/96 - see separate panel)
- 1,000 ft. water depth
- 650,000 bbls storage
- 300,000 BFPD
- 65,000 BOPD
  + 5 MMSCFD
  + 290,000 BWPD

Nan Hai Sheng Li

FPSO *Nanhai Sheng Li* Separators

TYPHOON EXPERIENCE

- **Comparison: 100 Year Typhoon Design Conditions vs. Super Typhoon Sally Hindsight Forecast**

	Omni Directional Typhoon Conditions	Super Typhoon "Sally"
Return Period (years)	100	> 100
Wind (knots): 30 min @ 10 m elevation	87	111
Wave Spectrum: gamma = 3.0; sigma = 0.1	JONSWAP P = 4.8	N/A
Significant Wave Height	43.3 ft / 13.2 m	N/A
Spectral Peak Period (sec)	14.7	N/A
Maximum Wave Height	78 ft / 23.8 m	88 ft / 27 m
Zero Crossing Period (sec)	11.5	N/A
Current Profile:		
D = depth (m) from MWL V = current velocity	0 226	0 100

NOTE: Sally passed about 10 miles South of Liuhua, exposing the field to "near optimally severe" conditions. Ocean Weather Inc. forecasted 140 kt. winds with gusts up to 170 kts.

Pemex Cantarell Field FSO

No downtime allowed!!

FSO *Ta' Kuntah*

- **Award June '97**
- **Ready to Install June '98**
- **1st Oil August 14, '98**
- **246 ft. water depth**
- **Hurricane prone area**
- **352,000 dwt tanker**
- **2.3 million bbl storage**
- **800,000 BPD loading**
- **Offloading to 2 shuttle tankers simultaneously**
- **2 x stern thrusters**
- **15 year life extension**

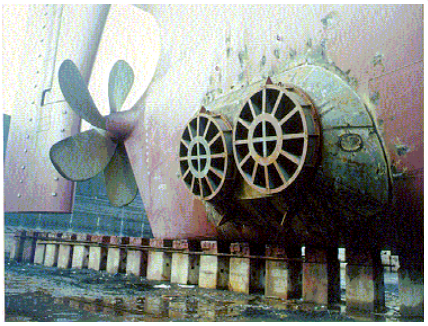
MODEC owned & operated under 10 + 5 year lease.

PEMEX CANTARELL FSO

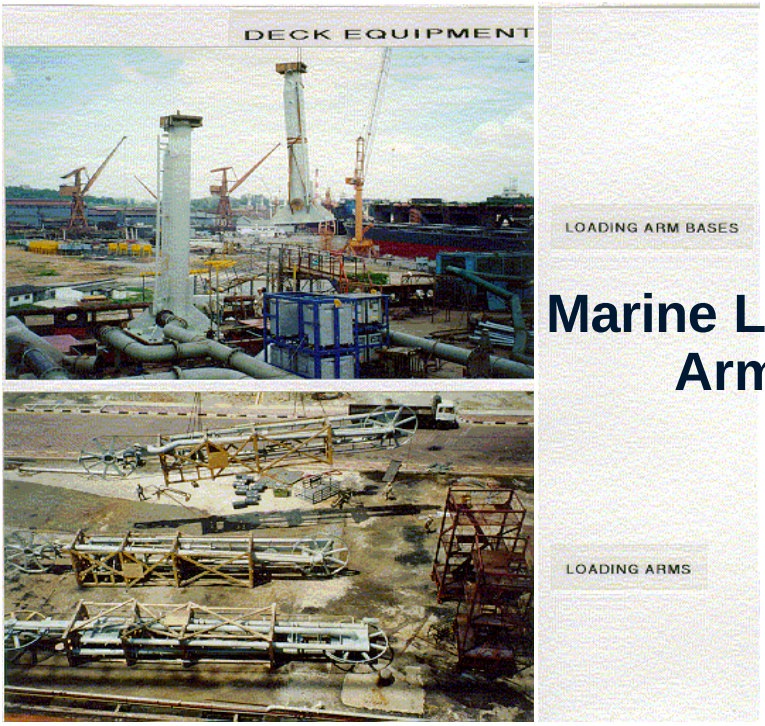
- Turnkey Contract for Design, Supply, Install & Operate FSO *Ta'Kuntah*
- Major elements:
  - Ship acquistion
  - Ship repair and life extension (15 years)
  - external turret (10 wire/chain lines piled)
  - installation of two stern thrusters
  - 2 x 16" I.D. Coflexip risers (up to 800,000 BOPD)
  - 2 x 20" floating hoses (up to 55,000 BPH in tandem)
  - 3 x 16" loading arms (up to 80,000 BPH side-by-side)
  - 7 Yokohama fenders
  - loading & offloading meters

Bottom Plate Replacement

New Steel Construction



Turret Head Installation



Marine Loading Arms

Operations Statistics

Duration:

August 15, 1998 – March 30, 2000

No. of Tankers Offloaded: 127

Total Barrels Offloaded: 70,726,188

Pollution Incidents: None

Downtime: None

Operations Statistics

- **The three Cayo Arcas SPMS closed on Sept. 1, 2000, for 9 days of maintenance.**
- **Production and terminal operation transferred entirely to FSO *Ta'Kuntah*:**
  - **Cargo loaded : 6,732,032**
  - **Daily Average Rate : 750,000 bbls (design = 800,000)**
  - **12 Simultaneous offloadings**
  - **2 Tandem offloadings**
- **Similar performances October 19 - 27, 2000, due to Cayo Arcas closure for metering calibration.**

FPSOs Present and Future

Advantages

	Conversion	New Build
Service Life w/ o drydocking	15 years or less	20 years or more
Cost	Less cost	More cost
Schedule	Less engineering, shipyard & transit time	More engineering, shipyard & transit time
Operator Preference	Varies	Varies
Regulatory Requirements	Varies	Varies

FPSOs Present and Future

Critical Areas - Hull & Marine Systems

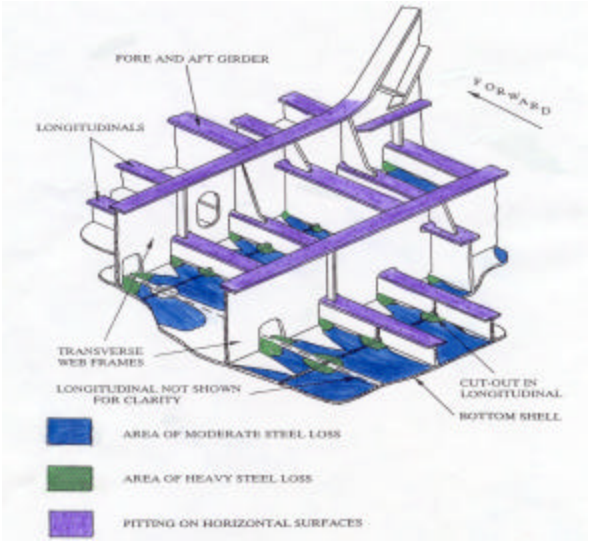
- Tank Arrangement
- Steel - Fatigue Life Assessment
  - Application of ABS/SafeHull technology to FPSO conversion
  - Thickness gauging
- Corrosion protection
- Piping systems & valves
- Inert gas system
- Boilers and steam
- Cargo pumps

FPSOs Present and Future

Problem Areas in Tankers - Experience Gained

1. Corrosion in cargo tanks bottom plates and in horizontal structures
2. Corrosion in ballast tanks
3. Cargo piping problems inside tanks
4. Fatigue Life

FPSOs Present and Future



Typical Wastage of Bottom Structure

FPSOs Present and Future

How to Avoid it:

1. Change in design concept
2. Minimize ballast shifting
3. Eliminate cargo piping in tanks
4. Emphasis on strict shipyard specifications and inspections
   - Structure
   - Coating
5. Change in coating specifications
   - Inorganic zinc
   - Pure epoxy
   - Hard coating in tank bottom

FPSOs Present and Future

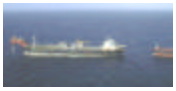
Engineering
Must be operations-oriented to:

- Minimize / zero downtime
- Reduce operations disruptions (time/cost) by facilitating:
  - Periodic maintenance
  - Periodic inspection
  - Repairs to maintain the required service life
- Reduce FPSO manning (OPEX and risk reduced)

FPSOs Present and Future







Conclusions:

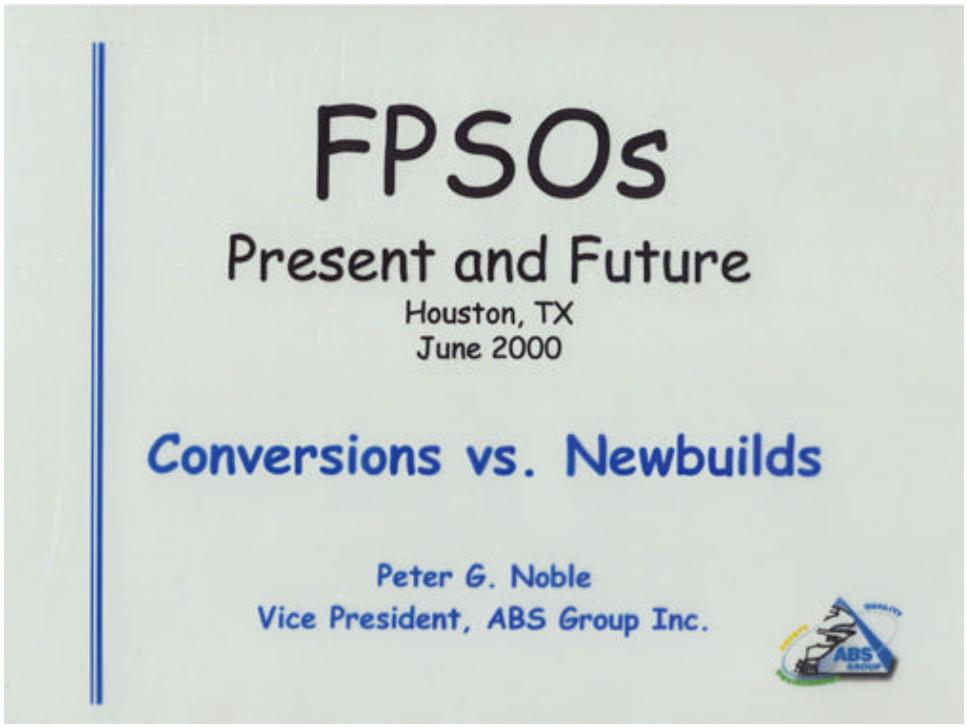
- Conversions and New Builds are Proven Options
- Decision Making Hinges on Several Factors, including Regulatory Prerogative
- Operations-focused Engineering and Expert Shipyard Supervision are Keys to Success





Peter Noble
ABS Group


BACKGROUND

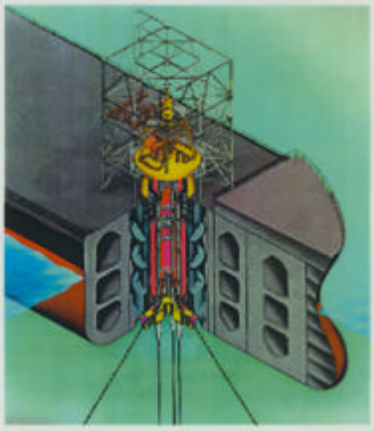

FPSOs
Present and Future
Houston, TX
June 2000
Conversions vs. Newbuilds
Peter G. Noble
Vice President, ABS Group Inc.

Principal Configurations of FPSO

- Internal Turret
- External Turret
- Spread Mooring - No Turret

Internal Turret FPSO

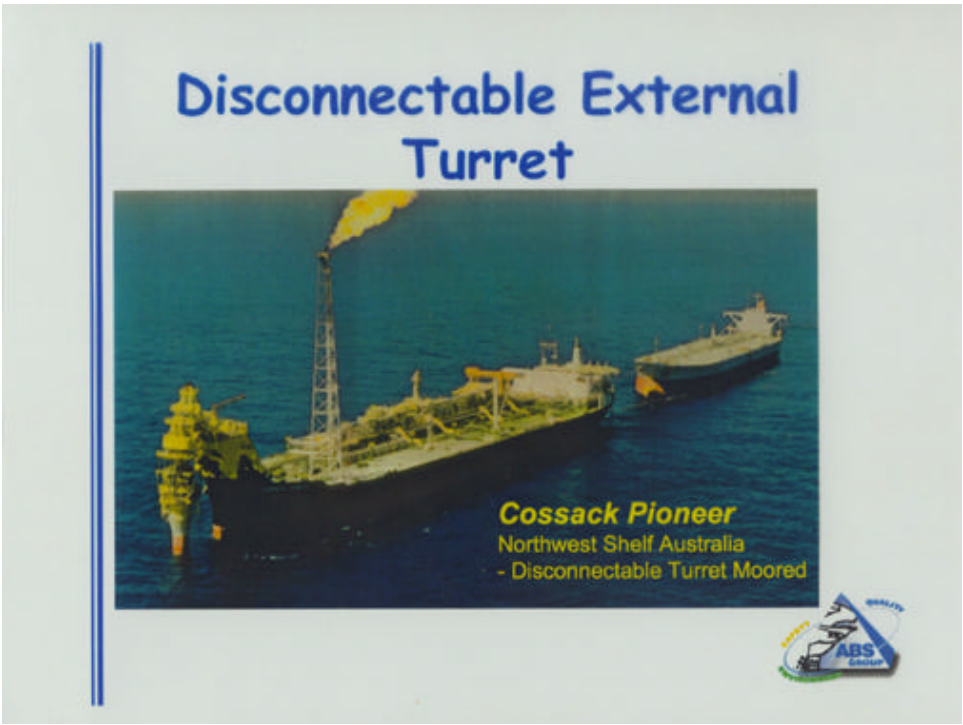
Liuhua FPSO, China



Internal Turret Mooring

Lufeng 13-1 FSO
for JHN
South China Sea,
Internal turret mooring

External Turret FSO


Disconnectable External Turret
Cossack Pioneer
Northwest Shelf Australia
- Disconnectable Turret Moored
ABS


External Turret
1st Purpose-Built LPG FSO
- Offshore Nigeria
- External Turret
ABS

PRINCIPAL ISSUES

Spread Moored FPSO

- Zafiro Producer
  - Equatorial Guinea
  - Spread mooring
  - Tandem installation of Harrier FSO

PRINCIPAL ISSUES
Conversion vs. Newbuild

- Schedule
- Cost
- Environment
- Regulatory Regime
  - Double Hulls/Double Sides
  - Disconnect/Self Propulsion

SCHEDULE

- Using an existing hull and converting may appear to save on the construction schedule but.....
  - long lead items (gas turbines, compressors, subsea equipment etc), may be what determines schedule
  - modification and repair of existing structures can take more time and effort than recognized at project initiation

COST

- Using an existing hull and converting may appear to save on the capital cost but.....
  - production equipment, turrets & mooring systems, subsea equipment etc tend to dominate costs.
  - modification and repair of existing structures can take more time and effort than recognized at project initiation, negating potential cost savings
  - operating expenses for maintenance and repair of conversions may be higher

ENVIRONMENT

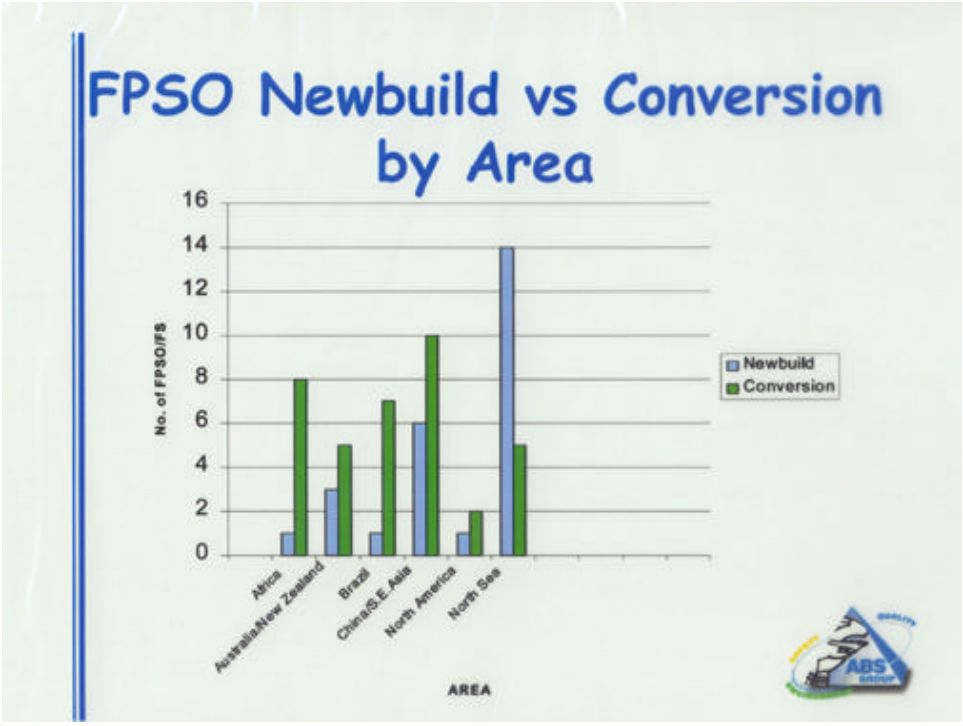
- Current data suggest that:
  - in low severity environments conversions are strongly preferred
  - in high severity environments newbuilds are strongly preferred
  - in medium severity environments conversions are preferred over newbuilds 2:1

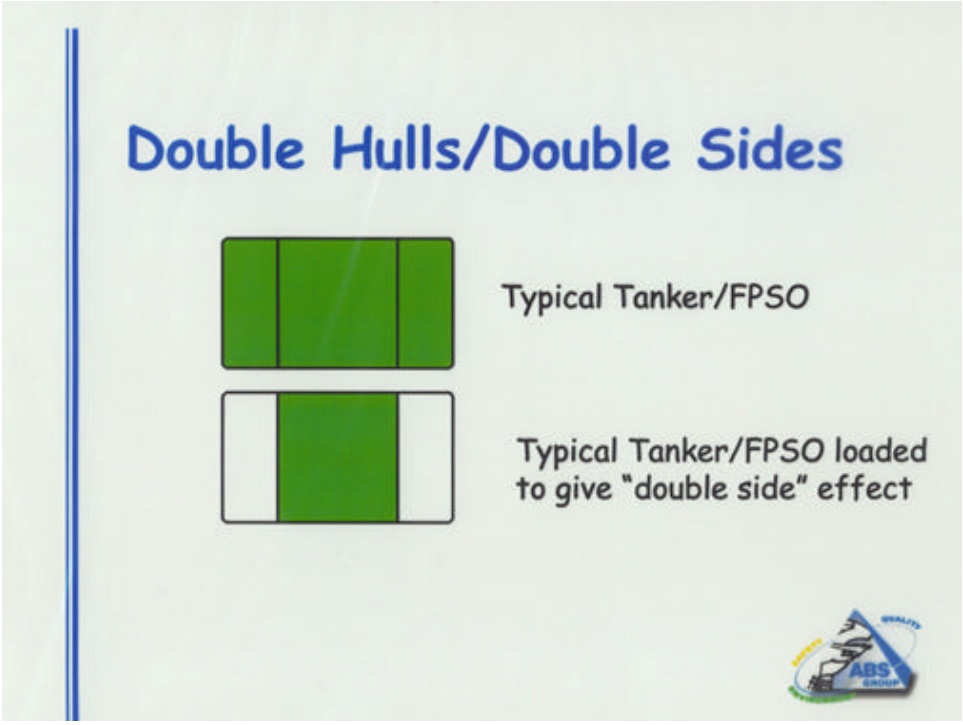
FPSO Conversions vs Newbuilds

Area	Newbuild	Conversion	TOTAL	% New	Severity of Environment
Africa	1	8	9	11%	Low
Australia/New Zealand	3	5	8	38%	Medium
Brazil	1	7	8	13%	Low
China/S.E.Asia	6	10	16	38%	Medium
North America	1	2	3	33%	Medium
North Sea	14	5	19	74%	High
TOTALS	26	37	63	41%	

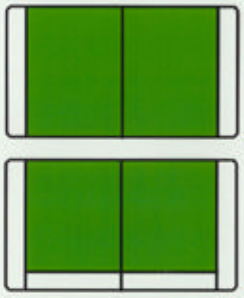
REGULATORY REGIME

- The current data suggest that:
  - highly regulated jurisdictions (i.e. Norway and U.K) appear to have a preference for newbuilds
  - Note: It should be recognized that the most severe operating environments and the highest regulated parts of the offshore industry appear to coincide.


FPSO Newbuild vs Conversion by Area
16
14
12
10
8
6
4
2
0
No. of FPSO/FS
Newbuild
Conversion
Africa
Australia/New Zealand
Brazil
China/S.E.Asia
North America
North Sea
AREA


Double Hulls/Double Sides
Typical Tanker/FPSO
Typical Tanker/FPSO loaded to give "double side" effect

Double Hulls/Double Sides



Typical double side FPSO

Typical hull side FPSO

Disconnect/Self Propulsion

- When using an existing ship as a basis for an FPSO the propulsion system comes "free" with the vessel which may be useful if disconnection is seen as viable operational option.
- Cost to maintain the propulsion system in a state of readiness and to keep the necessary marine crew aboard may be high